

## APPARATUS SYSTEM AND METHOD FOR GAS WELL SITE MONITORING

### **Related Applications**

This application claims the benefit of U.S. Provisional Application No. **60/405288** filed 23 August 2002.

### **Field of the Invention**

The present invention relates generally to gas well safety and particularly to early warning technologies for use in preventing injury to workers and populations adjacent gas well sites.

### **Background of the Invention**

Exploring and producing natural gas and crude oil has a whole variety of hazards. Flammable gas will be continually present during the processes involved requiring that plant and personnel be monitored for risk levels. Gas well sites are hazardous in a number of ways to both site workers and adjacent properties. Critical Leases are well sites that include a (significant) risk of escape of poisonous or explosive vapours "On Lease", typically in specific "critical zones" (also known as Hot Zones) separate from a work area or "Job Shack" from which workers monitor the entire well site. "Downwind" from such critical leases, poisonous vapours (an indicator of which is the combustion product generated during flaring activities) threaten nearby humans and livestock to different extents influenced by wind direction and speed. Geologists provide information respecting the location of "sour zones" such that for new wells Drilling Rig operators in cooperation with a Drilling Consultant will determine where to place Stationary Monitoring Units (SMUs) both On Lease and Downwind. Similarly, during the production phase of an existing well, Service Rig operators in cooperation with a Drilling Consultant will determine how to setup "forehead monitoring" and downwind equipment.

The Lower Explosive Limit (LEL) of a flammable gas is the minimum concentration of that gas, at normal ambient conditions, at which it will burn if there is a source of ignition

present. At a concentration below the LEL, the gas will not burn. Gas detectors for flammable gases are typically calibrated in the range 0-100% LEL. The actual concentration of the LEL varies from one gas to another. It has become industry practice that workers not enter spaces where the concentration of a gas exceeds 20% of the LEL because the concentration will vary at different places and it is likely that there will be pockets of gas that will exceed the LEL creating risk of explosion such that it is important to monitor LEL levels on such work sites. Further, various regulatory bodies impose monitoring requirements on lease requiring well site operators to track the percentage of the LEL of various flammable gases present on site.

Conventional technologies for "On Lease" monitoring provide relatively local audible and visual alarms that alert workers in the Job Shack, who must then "suit up" in chemical proof garments before approaching the hot zones to determine which of a plurality of such zones has entered alarm condition. Disadvantageously, the need to suit up creates delay in handling an emergency while the need to approach a hot zone creates (avoidable) risk to the worker. Conventional technologies for Downwind monitoring rely on a plurality of independent monitoring stations that may each communicate directly with a central monitoring station, such that a plurality of modems are deployed at significant expense for marginal benefit in redundancy.

Supervisory Control and Data Acquisition ("SCADA") systems have been used in industry to monitor and control plant status at the same time as providing records of that status or "logging" functionality. SCADA systems usually interface to the subject equipment in the plant using some form of programmable logic control ("PLC") device (useful stand-alone or in conjunction with a system to automate the monitoring and control of an industrial plant). As the name indicates, SCADA is not a full control system, but operates in a supervisory manner providing alarms that alert operators who then take manual control of the problematic equipment. SCADA is implemented as software positioned on top of the equipment to which it is interfaced using any suitable commercial hardware module. Systems similar to SCADA systems are often referred to as Distributed Control Systems (DCS), usually located within a confined area such that communication can be on a local area network (LAN) that is reliable and high speed. However, wireless Remote Terminal Units ("RTUs") can also be used to transfer to different

5 sites the data accessed from equipment being monitored and controlled. Typically the data acquisition is by an RTU including a PLC to receive the various inputs continuously delivered at high transfer rates by equipment hardwired to the RTU. In modern SCADA systems a host or master terminal unit then periodically scans or polls one or more wireless RTUs to gather the input data so acquired. This data can be analog or digital information gathered by monitoring sensors (e.g. flowmeter, ammeter), or data that controls equipment (e.g. relays, valves, motors) automatically or with operator intervention. Conventional SCADA systems use the RTU as a high reliability buffer and relay utility that can receive relatively large volumes of data and forward it as needed for processing by a host or master unit, the benefit of which is continuous logs that may be processed and re-processed by a host in different ways to extract information for different purposes as required. As host processing power has increased the buffering functionality of the RTU has become less important making it possible for systems (such as SMART described below) to have a plurality of sensors transmitting directly to the host without an RTU. Data whether buffered or directly transferred may be processed for a variety of purposes by a SCADA system, for example, the data is typically processed by the host to detect alarm conditions, and if an alarm is present, an alarm related interface can display notice of the condition causing the alarm. Conventional RTUs forwarding sensor traffic via RF to a master unit at a plant control center typically rely on relay towers or large antenna suitable for high power transmission, which for rapid deployment applications in remote locations (e.g. undeveloped regions of the Arctic) makes them either unavailable (e.g. no supporting infrastructure) or uneconomical (e.g. too expensive to justify transport) to implement for short-term, including emergency installations.

Although no patented prior art is known to the applicant, a number of companies providing portions of the above conventional solutions have been identified, including BW Technologies whose detection and analysis technology focus is efficiency rather than safety. The Rig Rat II is a microprocessor based gas detection apparatus detecting for combustibles, toxics, and/or oxygen hazards On Lease. With independent wireless radio signal transmission via coded radio channels the independently powered, solar capable detectors are easily moved. Rig Rat II is modular in design with plug-in ports for remote sensors, remote alarms, relays, and solar power. Installation costs are reduced by the use of wireless technologies, thereby eliminating cabling,

5 wiring, conduit and trenching. Although the Rig Rat II is intrinsically safe, permitting it to be  
deployed inside hot zones, it has no ability to transfer data to remote locations, through the  
InterNet or otherwise.

10 Further, SAT-TEL Corporation provides its SMART system for Downwind applications  
working with Iroc Systems Corp. Using Sat-Tel's SMART (Satellite Monitored Automated  
Reporting Terminal) monitoring technology assets are easily managed regardless of their  
geographic location. Sat-Tel configures existing technology to provide real-time monitoring via  
satellite communication. Unlike Rig Rat II, SMART is not intrinsically safe and cannot be  
15 deployed On Lease in hot zones. Like Rig Rat II, SMART units are self sufficiently powered by  
a 12V car battery charged via solar panel, tracking it's own power status. Designed to monitor  
four sensor inputs, such as humidity, weight, and wind speed. The Data Logger element of the  
SMART system takes samples at industry standard five second intervals, averaged every minute,  
and reported every fifteen minutes. Data is sent to Sat-Tel's call center via wireless fixed site  
20 satellite modem. Sat-Tel's SMART technology is specifically designed for H<sub>2</sub>S ppm, SO<sub>2</sub> ppb  
gas detection and is for use in only the downwind monitoring application. Further, SMART is  
based on proprietary MSAT communications links that support highly directional, one-way, data  
transmission only, making it necessary for operators to carry separate voice communication  
devices. SMART is characterized by unnecessary multiple redundancies in both data collection  
and transmission, with each unit requiring a separate MSAT satellite transponder and IP address  
25 (i.e. for each sensor station) multiplying communication costs. MSAT's reliance on static IP  
addressing disadvantageously creates a security risk, while its one-way configuration  
disadvantageously prevents remotely transmitting instructions to the equipment on a remote site.  
Further MSAT is not suitable for the transmission of Motion JPEG video images.

30 United States Patent Application **2001/0040509** ("509") filed by Dungan apparently  
teaches an apparatus and method for wireless gas monitoring, which purportedly improves over  
older Remote Terminal Unit ("RTU") based technology by allegedly "integrating" the transmitter  
in the same housing as the gas sensor or sensor array. Although not limited to satellite  
transmissions, in the 509 application at Figure 4 one embodiment is disclosed according to which

5 Low Earth Orbit ("LEO") satellite means are used to relay a signal from a Monitoring Station  
(14) adjacent a hazardous location to a remote Master Station (118) for further handling. Since  
the stated problem with the prior art RTUs is the need for "large" dish antennas having "higher  
gain", making it attractive to eliminate the use of "bulky and expensive" RTUs the LEO system  
operating at low altitude within relatively easy reach of less powerful transmitters is essential to  
10 the operation of the 509 system. Disadvantageously the LEO approach suffers from a "small  
footprint" limitation inherent in this low-power technology resulting in restrictions on the areas  
in which it may be deployed for remote access. The one-to-one transmitter-to-sensor  
correspondence of the 509 system is also very similar to SMART by Sat-Tel/IROC such that  
including the transmitter in the sensor housing is characterized by unnecessary multiple  
15 redundancies in high-powered data transmission whenever a plurality of sensors are deployed.  
Both 509 and SMART implement a "stand-alone" independent sensor & transmitter combination  
according to which each sensor or monitoring station sends data to a remote "master" (whether  
on-site or off-site respecting the gas detection location) that responds in some manner to the  
information carried in such data. Although the amount of data so transmitted can vary (e.g.  
20 normal vs. alarm mode) both 509 and SMART necessitate significant overhead in air-time for  
the transmission of data, when used in remote sensing applications disadvantageously resulting  
in the consumption of expensive (high-powered, long-distance) bandwidth during each  
transmission from each sensor station. Aggravating the above situation is the commensurate  
consumption of extra IP-addresses by the unnecessary multiple redundancy of the configuration  
25 of the 509 and SMART systems, dictating one IP address per sensor station, when equivalent  
information about each station may now be transmitted without consuming one IP-address per  
station. 509 further teaches at para. 70 a large number of very rapid sensor signal transmissions  
such that no averaging or pre-processing at the sensor station is permitted since "each monitoring  
device 14 will very rapidly transmit its readings to an output center. Because these transmissions  
30 occur so often, there is insufficient time for data readings to accumulate between transmissions.",  
which failure to pre-process data from sensor stations further increases the burden on the  
communications system and budget. It is therefore desirable to both process and transmit sensor  
data in a manner that reduces the amount of data sent and the communication uplink usage time  
– without compromising the quality or completeness of the information required to achieve the

5 system objectives of location targeted early warning, nature and direction of gas escape, and sufficient records to comply with local regulations.

10 A common problem with all gas sensors, especially those operating at remote sites, is anomalous readings (false alarms) resulting from substantial shifts in temperature, wind speed, humidity or other atmospheric conditions that influence the (best) interpretation of the raw signal from sensors. It is desirable to compensate for such changes in atmospheric conditions (resulting for example from forest fires and fast moving cold fronts – common in mountainous terrain) by adjusting the interpretation of sensor data, before it is processed, by averaging unadjusted data into other data that would be distorted by its inclusion.

15 All known conventional well-site monitoring systems are wireless, use a 19.2kbps data communication IP connection, and are independently powered, but are limited to either On Lease or Downwind applications and use relatively expensive and inflexible technologies. There is a need for a relatively simple and affordable integrated system that may be used in a variety of applications to communicate remotely using the InterNet efficiently transferring information regarding several sensors via a single IP address. None of the known conventional technologies temperature compensates sensor data. None of the known conventional technologies integrates video security functionality with its gas monitoring.

25 Schlumberger's new product currently known as "InterACT" is described as providing "secure, real-time, Web-based exploration, development and production data." InterACT allegedly permits authorized team members located anywhere around the globe to view data in the course of collaborative decision making. It is further described as suitable for: Remote data acquisition and delivery; Two-way communication and distribution of real-time drilling, wireline, stimulation and production information; Selective sharing of data among several parties; Remote monitoring of well-site operations; and Supervisory control of remote assets. Although limited information is currently available respecting how it allegedly achieves the above functionality, it is believed that in the Remote monitoring application the InterACT system uses a group of local sensor stations that transmit via RF to a relay device that forwards data via FTP to a server off-site for viewing by users. Disadvantageously, when the InterACT monitoring system is setup in an area having access to both (less expensive) cellular service and (more

5 reliable) satellite service, the communications element has no means to auto-detect, auto-select, and auto-switch between satellite and cellular communication modes whenever and as it becomes appropriate to do so. The InterACT system also fails to provide for dual voice-IP usage of the communication system.

10 United States Patent Application 20020155622 ("622") by Slater et al. purports to teach a "toxic gas monitoring system" based on individual (slave) radio-paging units worn by workers in hazardous areas. According to one embodiment the pagers receive an alarm signal from a centrally located (master) sensor unit and transmitter, which signal warns all workers of the presence of gas in the subject work space. According to another embodiment the pagers each  
15 include a gas sensor, are self-identifying, and have 2-way communication capability including a "panic button" such that any pager can trigger the entire system into alarm. According to a third embodiment the 2-way pagers and their centrally located (master) sensor unit each communicate with an external resource such as a rescue crew. 622 contemplates a group of such systems operating in "repair cells" to cover a large industrial facility. There is no indication in 622 that  
20 much more than simple signals are exchanged over limited distances to trigger events such as alarms that alert operators and supporting resources to the presence of gas.

Industrial facilities commonly use the popular HART® protocol for which a wide array of reliable and affordable peripheral devices have been developed over years. The HART®  
25 Multiplexor system facilitates the gathering of HART® protocol data in order to permit asset management by those who operate and maintain a plant. Data is gathered via a plug-in modular unit housed on a field termination board. The multiplexor and fieldgates enable the use of a PC for the remote monitoring, remote diagnosis and remote configuration of connected HART® sensors and actuators, via telephone lines (analogue and ISDN), Ethernet TCP/IP, or mobile  
30 communications (e.g. GSM). Communication with the field device is a sub-layered service that does not interrupt the measurement signal, such that data access procedures have no influence on the measured value processing performed by associated process control and instrument systems. Consequently, it is desirable for remote access applications to have available means for connecting "off the shelf" sensors and other peripherals from which data may be gathered and  
35 which connection employs a popular and reliable industry standard.

## Summary of the Invention

The system aspect of the present invention is an innovative use of new and existing technology comprising a simple and affordable package functional in a variety of applications that communicate with a remotely located monitoring, control, and record keeping centre via the InterNet. By using the InterNet for the secure transmission of data from the system of the present invention either directly to users or through a server, user location flexibility and convenience is dramatically enhanced, permitting users to access data in transit and using "hotspots" without prior setup required. In order to overcome the disadvantages of the prior art a novel system for On Lease or Downwind monitoring has been created according to which hot zones are monitored remotely and adjacent properties are protected by a single communications device having a plurality of SMUs. Advantageously workers no longer need to suit up or even risk leaving a pressure positive Job Shack in order to determine the origin of an alarm generated by conventional technologies. Advantageously operators no longer need to pay for multiple IP addresses or have redundant telecommunications devices to deliver the relatively small data streams necessary to fully protect workers and adjacent properties.

The gas monitoring system of the present invention is suitable for rapid deployment in remote areas not having access to infrastructure. It uses high-powered data transfer resources (e.g. long-distance communication via satellite or cellular) efficiently and affordably by both processing and transmitting gas sensor data in a manner that reduces the communication uplink usage time - without compromising the quality or completeness of the information required to achieve the system objectives of: location targeted early warning, detailed information respecting the nature and direction of the gas escape, and sufficient records to comply with local regulations. For example, the system of the present invention requires only one IP address per sensor station group, yet provides equivalent information about each sensor station, but overcomes the disadvantage of the prior art that commonly used one IP-address per sensor station. Similarly by suitably pre-processing sensor data significant advantages are achieved in bandwidth efficiency during normal mode operation, without precluding the transmission of full sets of sensor data, when a system enters alarm mode, for later reprocessing. And the CCI element of the system of the present invention also identifies the "modem of preference" using on-board RSSI (relative signal strength indicator) detection technology to determine which



5       modem best satisfies the rules pre-defined for the particular circumstances – all thereby reducing  
the burden on the communications system and budget over the life of the installation of each  
system.

10       Pre-compensating for local weather anomalies and modularly constructed from  
reconfigurable elements, the system of the present invention is further suitable for such rapid  
deployment application in easily customized packages for a particular location regardless of the  
changes in weather and other local factors such as intermittent access to communication with a  
remote call center or other monitoring facility that provides archive, user access, regulatory  
tracking, emergency service links and other advantageous functionality. The option for low-  
15       power transmission between sensor devices and one or more CCI (message processor) devices  
not only provides for an efficient use communications resources but effectively also serves to  
provide fail-over capacity for each CCI.

20       Although it is desirable for all installations, it is particularly important for remote access  
applications (where security is normally important and parts are difficult to obtain) that the  
system of the present invention contemplates and facilitates the connection of "off the shelf"  
sensors and other peripherals (e.g. video imaging service and HART® protocol devices) from  
which data may be gathered or which connection is effected using a popular and reliable industry  
standard.

25       Global Positioning System (GPS) equipment is used to locate Universal Transverse  
Mercator (UTM) grid readings typically specified by a regulatory body who determines how  
many SMUs of each type need to be deployed and where they must be placed. Once the physical  
site for a SMU is located, whether according to the known hot zones On Lease or via UTM  
30       readings downwind, system initialization can proceed.

35       In the Downwind configuration the system operator positions a SMU including a Sensor  
Interface Transceiver (SIT) SIT-02 (with H<sub>2</sub>S and/or SO<sub>2</sub> sensors) apparatus on a UTM and  
connects any common GPS measuring device to the SIT-02 (via a serial port) to confirm the  
accuracy of the required positioning. SMU install locations will typically be less than 1 km apart

with the Command Control Interface (CCI) centrally located between SMUs to obtain maximum coverage. Since the downwind configuration of the system is never in a hot zone, there is no requirement that the CCI be intrinsically safe – permitting a less expensive housing to be used for each of the SIT-02 units and the supporting CCI. When the system is setup communications are first tested and then the sensors are tested by the application of a (“bump gas”) sample of each gas that the particular sensor is designed to detect in order to verify operation in the field, all SMUs having been previously calibrated and tested under lab conditions. The CCI includes a built-in voice-capable phone (Cellular or Satellite) that permits operators to immediately verify if the correct readings are being registered at the remote call center.

Remote monitoring within the perimeter of a Critical Lease is enabled when the On Lease configuration of the system aspect of the present invention deploys a plurality of SIT-01 to relay information locally over relatively short distances from a plurality of external (gas detection and analysis) sensor units (typically the Rig Rat II) via RF (typically at 900 MHz) to a CCI that provides logging and long-distance remote (Cellular or Satellite) communication capability. Similarly, the Downwind configuration of the system of the present invention involves the local relay of information from a plurality of SIT-02 via RF to a CCI that provides long-distance remote communication capability.

In both configurations the CCI transmits via a Cellular Digital Packet Data (“CDPD”) network if it is available at the site location, or in the alternative via Globalstar Qualcomm satellite link to a remote call centre where both normal and alarm data are monitored and processed. The selection (set via DIP switch) of CDPD or Satellite communications is made onboard the CCI at the time of installation when the equipment install location is known and confirmed such that it can be determined whether the less expensive cellular communication option is available. However Globalstar technology can work on CDMA cellular service and kick up to satellite when out of the cellular zone. In a preferred embodiment the Globalstar system deployed advantageously operates with a dynamic IP, which is significantly more secure against hacking.

According to one aspect of the invention there is provided a novel intrinsically safe electronic system having a central communication interface, for use with means for gas detection and analysis located on a sour gas or critical lease well site, the system comprising: a source of electrical energy; means for receiving at least one analog signal from said gas detection and analysis means for the purpose of identifying the nature and presence or concentration of at least one gas; an A/D converter for converting said at least one analog signal to a digital signal; and wireless means for transmitting said digital signal to said central communication interface for further handling, wherein said central communication interface comprises: a micro-controller having a memory stack; ROM and EEPROM; solar charging and power regulation circuitry; at least one serial bus and port; an atmospheric conditions interface for receiving sensor input respecting at least one atmospheric condition; wireless means for receiving said digital signal; means for storing and processing said digital signal for the purpose of creating and maintaining a data log respecting the nature and presence or concentration of at least one gas over varying periods of time; wireless means for transmitting said data log to a remote location; and an intrinsically safe housing. Further wherein said source of electrical energy comprises at least one battery together with solar powered means for charging said at least one battery. Further wherein said means for receiving said at least one analog signal from said gas detection and analysis means comprises a serial connection port and suitable cable. Further comprising means for detecting the percentage of the Lower Explosive Limit ("LEL") level of a flammable gas in the air on said well site. Further wherein said wireless means for transmitting said digital signals to said central communication interface comprises an intrinsically safe communications relay apparatus that operates within the Radio Frequency portion of the electromagnetic spectrum at any suitable frequency therein. Further wherein said wireless means for transmitting said data log to a remote location comprises a modem adaptable to transmitting through a Cellular Digital Packet Data network and accessing any such suitable network using internet protocol together with any suitable router or similar device in order to transfer said data log using an IP address. Further wherein said means for storing and processing said digital signal comprises a micro-controller together with a firmware module and any suitable memory means. Further wherein wherein said wireless means for transmitting said data log to a remote location comprises a satellite transponder accessing a satellite network using internet protocol together with any suitable router or similar device in order to transfer said data log using an IP address. Further

5 comprising any suitable camera, video transmitter and video server device for capturing and compressing digital images together with suitable switching means, for transmission using said wireless means for transmitting said data log to a remote location. And, further comprising onboard voice phone communication means housed with said central communication interface.

10 According to one aspect of the invention there is provided a novel electronic system having a central communication interface, for use downwind from a sour gas or critical lease well site, the system comprising: a plurality of sensor interface means for gas detection and signal generation each producing at least one digital signal representing the nature and presence or concentration of at least one gas in proximity thereto; and a source of electrical energy for  
15 each said sensor interface means, wherein each said sensor interface means has wireless means for transmitting said digital signal to said central communication interface for further handling. Further wherein said sensor interface means for gas detection and signal generation comprises: a source of electrical energy; a micro-controller having embedded firmware and a memory stack; solar charging and power regulation circuitry; at least one serial bus and port; an atmospheric  
20 conditions interface for receiving sensor input respecting at least one atmospheric condition; at least one input port for connecting a gas sensor for the purpose of receiving at least one analog signal from said sensor; an A/D converter for converting said at least one analog signal to a digital signal; and wireless means for transmitting said digital signal to said central communication interface for further handling. Further wherein said central communication  
25 interface is provided with wireless means for transmitting a data log to a remote location, and said central communication interface comprises: a micro-controller having a memory stack; ROM and EEPROM; solar charging and power regulation circuitry; at least one serial bus and port; an atmospheric conditions interface for receiving sensor input respecting at least one atmospheric condition; wireless means for receiving said digital signal; means for storing and  
30 processing said digital signal for the purpose of creating and maintaining a data log respecting the nature and presence or concentration of at least one gas over varying periods of time; and onboard voice phone communications. Further wherein said source of electrical energy comprises at least one battery together with solar powered means for charging said at least one battery. Further wherein said analog signal represents the ppm of H<sub>2</sub>S or the ppb of SO<sub>2</sub> in the air  
35 downwind from said well site. Further wherein said wireless means for transmitting said digital

5 signals to said central communication interface comprises a communications relay apparatus that operates within the Radio Frequency portion of the electromagnetic spectrum at any suitable frequency therein. Further wherein said wireless means for transmitting said data log to a remote location comprises a modem adaptable to transmitting through a Cellular Digital Packet Data network and accessing any such suitable network using internet protocol together with any  
10 suitable router or similar device in order to transfer said data log using an IP address. Further wherein said means for storing and processing said digital signal comprises a micro-controller together with a firmware module and any suitable memory means. Further wherein said wireless means for transmitting said data log to a remote location comprises a satellite transponder accessing a satellite network using internet protocol together with any suitable router or similar  
15 device in order to transfer said data log using an IP address. Further comprising any suitable camera, video transmitter and video server device for capturing and compressing digital images together with suitable switching means, for transmission using said wireless means for transmitting said data log to a remote location. Further wherein said at least one atmospheric condition comprises wind direction, wind speed, temperature, or humidity.

20 According to another aspect of the invention there is provided a novel method of initializing a system having a central communication interface, for use with means for gas detection and analysis, located on a critical lease well site, or for use downwind from said critical lease well site, comprising the steps: apply power to said central communication interface; verify  
25 communications between said central communication interface and all SIT units; test each SIT and sensor using bump gas means to send each sensor to alarm; physically chart the sensor readings; and use onboard voice phone means to confirm output accuracy. Further wherein said phone comprises a Globalstar transponder.

30 There is further provided a novel method of implementing and operating a system having a central communication interface, for use with means for gas detection and analysis, located on a critical lease well site, or for use downwind from said critical lease well site, comprising the steps: obtaining and verifying data relating to the presence of gas on lease; determining ambient atmospheric conditions, including air temperature, wind speed and direction, humidity from at  
35 least one location either On Lease at said site or Downwind from said site; adjusting (for the

5 purpose of reducing anomalous readings) said obtained data if required to account for recent changes in said atmospheric determinations; if said data is outside preset alarm parameters, then storing said data for use in averaging said data at predetermined intervals for later transmission; or if said data is within preset alarm parameters, then entering a pre-configured mode for immediate transmission; and transmitting said data for further processing at a remote location.

10 According to one aspect of the invention there is provided an apparatus for accepting and converting, to digital, analog data from at least one gas sensor and wirelessly transmitting said digital data to a central communication interface, said apparatus comprising: a source of electrical energy; a sensor interface; means for receiving said raw data from sensors via said  
15 sensor interface; a sensor interpretation and signal generation firmware module; means for processing at least one signal into a digital form; and wireless means for transmitting said signal to said central communication interface. The apparatus further comprises an atmospheric conditions interface providing analog data respecting at least one atmospheric parameter such as for example, but not in limitation, temperature, wind direction, wind speed, or humidity.

20 The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate preferred embodiments of the method, system, and apparatus according to the invention and, together with the description, serve to explain the principles of the invention.

### **Brief Description of the Drawings**

25 The present invention, in order to be easily understood and practiced, is set out in the following non-limiting examples shown in the accompanying drawings, in which:

**Figure 1** illustrates one embodiment of the system of the present invention configured for an intrinsically safe on-lease installation at a critical lease;

30 **Figure 2** illustrates one embodiment of the system of the present invention configured for downwind installation;

**Figure 3** illustrates one embodiment of the system of the present invention configured for both on-lease and downwind installation;

**Figure 4** illustrates in a block diagram one embodiment of the CCI combined with long-distance communication as an element of the system of the present invention;

**Figure 5** illustrates in a block diagram one embodiment of the SIT-02 element of the system of the present invention;

**Figure 6** illustrates one embodiment of the SIT-01 element of the system of the present invention for use as a transmitting relay forwarding data gathered by a third party sensor and logging unit;

**Figure 7** illustrates one embodiment of the SIT-02 element of the system of the present invention in use with at least one external gas sensing unit from which it processes and forwards data;

**Figure 8** illustrates one embodiment of the system of the present invention configured in its "server mode" providing data directly to Users;

**Figure 9** illustrates one embodiment of the system of the present invention configured in its "client mode" providing data to an external host or server that Users access to reach value-added version of the data from one or more of a plurality of locations; and

**Figure 10** illustrates in a block diagram one embodiment of the CCI element combined with the SIT element of the system of the present invention.

#### **Detailed Description of the Preferred Embodiment**

Referring to Figure 1 there is illustrated an electronic system including an intrinsically safe Central Communication Interface ("CCI"), multi-mode long-distance communications

capability, and a plurality of Sensor Interface Transceivers ("SIT"), together denoted generally as 100, the system 100 being for placement on-site at a critical lease (i.e. hazardous) well site. The CCI element has two configurations being CCI-01 (On Lease) 120 and CCI-02 (Downwind) 220 as set out in Figure 2. Similarly the SIT element has two configurations being SIT-01 110 and SIT-02 210 as set out in Figure 2. It is contemplated that the use of a configurable base design for each of the CCI and SIT will lead to manufacturing and production advantages in that the elements of the system of the present invention will be easily substitutable to meet different inventory and operational needs quickly, but affordably.

According to one embodiment, system 100 comprises at least one SIT 110, CCI 120, atmospheric condition sensor array 130, multi-mode long-distance communications apparatus 420, and self-sustaining power source 140 that according to a preferred embodiment is comprised of a battery together with a solar panel 141 and suitable charging circuitry including voltage regulation. Each SIT 110 has at least one sensor unit 115 and accepts at least one optional sensor 112. Each SIT 110 pre-processes (analog or digital) sampled data from sensor units 115 according to programmable circumstances, in a programmable manner, and to a programmable extent in order to ensure that the information required (whether dictated by regulation or otherwise) is available to operators, but without consuming bandwidth unnecessarily. CCI 120 accepts data streams from a plurality of SIT 110 via local (typically low power RF) communication technology and then further processes that data for relay off-site typically using a suitable modem in transceiver that is multi-mode long-distance communications apparatus 420 having access to cellular (CDPD) and satellite transponders over a network. *According to one embodiment the selection of CDPD or Satellite communications is (set via DIP switch) made onboard the CCI at the time of installation when the equipment install location is known and confirmed such that it can be determined whether the less expensive cellular communication option is available. However Globalstar technology can also work on CDMA cellular service and kick up to satellite when out of the cellular zone. According to a preferred embodiment the selection of the CDPD or Satellite communication mode is made automatically using optional switch 340 (seen in Figure 4) that automatically senses the relative signal strength of each said mode determines which to use according to pre-defined rules. As set out in more detail below CCI 120 operates in more than one mode determined by events detected On Lease.*



In normal operating conditions (i.e. acceptable levels of various gases) sample rates and transmission rates are lower than in emergency or alarm conditions during which data transmissions off-site may be continuous. To reduce the risk that transient conditions at sensor locations will trigger an alarm, according to a preferred embodiment, the processing of CCI 120 includes compensation for atmospheric conditions using data provided by array 130 directly to CCI 120. The housings used in the elements of system 100 are intrinsically safe (e.g. explosion proof) since system 100 must be placed inside critical or "hot" zones On Lease where it provides advantages never before available.

According to one embodiment, system 100 deploys 4 SIT 110 devices each of which receives (analog or digital) data from a third party sensor unit 115 such as the BW Technologies Rig Rat II. Typically each SIT 110 communicates with a single CCI 120 to which it relays the digital form of analog data that the SIT 110 received and converted. All data relays by SIT 110 are wireless RF at any suitable and available frequency, but in one embodiment operate at 900 MHz. CCI 120 performs a variety of processing operations on the data, including accumulation and averaging. According to a further embodiment each SIT 110 may, in either normal or fail-over mode, communicate with more than one CCI 110.

Each of the two configurations of CCI has at least two modes of operation, normal and alarm. According to a preferred embodiment of CCI 120 operating in normal mode, sample readings are taken every 5 seconds from each SIT 110. Upon accumulating 12 samples (i.e. every 1 minute) from each of the (typically 4) SIT 110 with which it communicates, CCI 120 determines an average for each SIT 110 and records same in Logging Memory 414b (seen in Figure 4). At the same time as logging SIT 110 readings CCI 120 records a variety of atmospheric condition (including, but not limited to temperature and wind speed) readings received from array 130 via interface 415. Typically CCI 120 will have sufficient Logging Memory 414b (normally implemented using EEPROM) to accumulate between 2 and 3 hours of data, but in practise CCI 120 may be programmed to transmit all data, thereby clearing its memory registers, every 30 minutes while in normal mode. The accumulation of data is done for economic reasons because the use of satellite means to transmit data remotely is currently relatively expensive. It is contemplated that less or more memory may be used with shorter or

5 longer accumulation periods suited to using CDPD transmission or a smaller client respectively. During transmission CCI 120 sends data in digital format via either CDPD or Satellite means to a remote network that delivers the data to a predetermined IP address from which it may be securely accessed, in client mode or server mode as shown in Figures 8 and 9, for a variety of purposes. System 100 uses the data from atmospheric condition sensor array 130 (when CCI 120 processes the gas data that it receives from all SIT 110) to compensate for changes in atmospheric conditions that create spikes or other misleading shifts in the processed gas data. This adjustment advantageously results in fewer anomalous readings in the data that CCI 120 transmits via either cellular or satellite link to a remote monitoring facility or call centre (not shown).

15 Well site infrastructure is neither required nor relied on with self-sustaining power source 140 used in the On Lease configuration because system 100 operates as an emergency warning system that must continue to operate even if power is lost to the well site - since the loss of well site power would frequently be related to the very type of emergency that system 100 is deployed to detect, monitor, and alert well operators respecting.

20 To cause it to enter "alarm mode" CCI 120 typically receives an alarm signal via a SIT 110, but generated by a sensor unit 115. CCI 120 may be programmed to react in a variety of ways while in alarm mode, but in a preferred embodiment CCI 120 immediately transmits the contents of its buffer together with a signal generating an e-mail alert to at least one remote monitoring call centre. CCI 120 will typically remain in alarm state until operators intervene to confirm a state of emergency or reset system 100. While in alarm mode CCI 120 typically transmits the contents of its logging memory 414b more frequently than in normal mode, but the period between transmissions may be determined by the well site operator based on the nature of the data transmitted, the location of the well site, the cost of transmission, or a variety of other factors. Particularly while connected to a CDPD transmission means, CCI 120 may be remotely caused to transmit the contents of its memory at any time by sending a "request" for the last sample reading. Due to current limitations on satellite technology, while connected to Satellite transmission means, CCI 120 connects to the satellite network according to a pre-programmed schedule, which includes the point at which alarm mode is first entered.

5           At each of CCI 120 and CCI 220 “data logging” takes place with a plurality of sample  
reading signals received from each SIT 110 or SIT 210 accumulated over a (programmable)  
period of time at the end of which the signals are averaged and the average is recorded or  
“logged” (typically in EEPROM 414b) by the CCI 120 or CCI 220 which then accepts a further  
10           plurality of signals from each SIT 110 or CCI 210 to create another average for each SIT 110 or  
SIT 210, each of which averages is again logged. The sequence of accumulation, averaging, and  
logging for each SIT is repeated continuously until either the expiry of a programmable period of  
time or an alarm signal is received, upon either of which events the CCI sends data to a modem  
for transmission to a call centre, where a “library” of the readings from each SIT is created  
15           together with date, time, location and any other information useful to the customer operating the  
monitored well site. The library data may be used in a variety of ways that include the burning of  
discs of comprehensive record for clients as well as the generation of online graphs that display  
historical and current levels and trends visually for monitoring.

20           According to a preferred embodiment of system 100, SIT 110, although capable of  
accepting raw input from sensor 112, receives its data from a more sophisticated sensor unit 115  
such as a gas analyser that detects and measures a wide range of different flammable (LEL%)  
and noxious gases. Sensor unit 115 will typically provide sufficient electrical power to operate  
its SIT 110. System 100 is a very bandwidth efficient and cost effective application of  
25           technology to prevent a man down scenario while in full compliance with all government  
regulations. Through 2-way RF communication with sensor units 115, system 100 requires only  
one modem for a plurality of SMUs (here each comprised of a SIT 110 and at least one sensor  
unit 115) to implement real time 24/7 monitoring virtually anywhere in the world. By deploying  
a variety of sensor combinations, system 100 provides early warning of: H<sub>2</sub>S ppm, LEL  
30           percentages, H<sub>2</sub>S ppm, SO<sub>2</sub> ppb, as well as security and other threats via event driven JPEG  
video.

Referring to Figure 2 there is illustrated an electronic system, designed to be located  
downwind from a critical lease well site, and denoted generally as 200. Since system 200 is  
typically not located inside a hazardous space, government regulations typically do not require  
35           that it include intrinsically safe housings on each element. Each system 200 comprises: a CCI

5 220, at least one SIT 210 each having at least one sensor 116, atmospheric condition sensor array 130, and self-sustaining power sources 140 and 240. System 200 relays data from at least one sensor 116 off site typically using multi-mode long-distance communications apparatus 420. Unlike system 100, system 200 is located remote from any critical or "hot" zones as a result of which system 200 is not exposed to flammable gas while monitoring for H<sub>2</sub>S or combustion  
10 product SO<sub>2</sub>. SIT 210 is neither dependent upon (e.g. for power) nor enslaved to an external gas detection and analysis sensor unit 115, such that SIT 210 is connected directly to at least one sensor 116 from which it accepts raw data for processing prior to RF wireless transmission of the processed sensor data to CCI 220 for further processing as required and then remote transmission via cellular (CDPD) or satellite (using multi-mode long-distance communications apparatus 420)  
15 to a remote network that delivers the data to a predetermined IP address from which it may be securely accessed for a variety of purposes. Power source 240 is substantially similar to power source 140, (both comprised of a battery together with a solar collector panel and suitable charging circuitry including voltage regulation) however the total output (amp hours) and the solar panel 141 size required to maintain charge on the batteries is matched to the lower power  
20 consumption of the SIT 210 as compared to the power consumption of the CCI 120 or the CCI 220.

When CCI 220 processes the data that it receives via RF from each SIT 210 the data from atmospheric condition sensor array 130 is used to compensate for changes in atmospheric  
25 conditions that create spikes or other misleading shifts in the processed gas data. Although the placement of each SIT 210 may be dictated by a UTM provided by a government authority, the placement of CCI 220 is determined mainly by the terrain and the range of the particular RF wireless elements used. Typically, with 900 MHz RF communication between it and a CCI 220, each SIT 210 operating as an SMU is located within 1 km of CCI 220. System 200  
30 advantageously requires only a single modem (either Cellular or Satellite) at any time to transfer all the data gathered from a plurality of sensor 116 connected to each of a plurality of SIT 210 - providing substantial economy of equipment and communication services costs, as well as reducing the phone numbers and IP addresses that are required to setup and operate conventional downwind technology.

5           According to a preferred embodiment of systems 100 and 200, CCI 120 and CCI 220 are self-selecting using signal detection and embedded rules to self-select between CDPD and Satellite mode of communication to be used by multi-mode long-distance communications apparatus 420 at a given location and time as well as in accordance with whether or not the CCI is in normal or alarm mode. Although CDPD is at the time of writing often used for economy, it is contemplated that over time the cost of Satellite communication will decrease and erode the current price advantage of Cellular. Further, particularly as the usage of the once inexpensive CDPD technology increases together with the typical increases in the resulting transmission delays (often due to a higher priority status being granted to more profitable voice traffic) of increased popularity, the selection of satellite mode will be even easier to make for the emergent circumstances normally associated with an alarm condition in the course of monitoring gas wells.

Referring to Figure 3 there is illustrated an embodiment of the system of the present invention denoted generally as 300 being the combination of system 100 and system 200. As shown, each subsystem 211 comprises a SIT 210, at least one sensor 116, and a power supply 240. System 300 provides both Downwind and On Lease gas escape detection together with video security respecting a well-site. Each SIT 110 is placed at a location within the critical lease perimeter inside which all equipment must be intrinsically safe to reduce the risk of explosion or fire. Typically, CCI 120 will be located in or near a Job Shack from which site workers operate. In conjunction with system 100 detecting a release of H<sub>2</sub>S (for example) gas, system 200 operating downwind provides backup detection and gas cloud movement data. For example, if the third party external gas detection and analysis device, sensor unit 155, supplying data to a SIT 110 downwind of all other devices on lease failed in windy conditions, then any of the 4 independently operating subsystem 211 located downwind could detect the escaped gas and via system 200 alert operators prior to any alarm (local or remote) sounding on lease or generated remotely by any on lease protective system including system 100.

According to a preferred embodiment of system 300, CCI 120 and CCI 220 both cooperate via RF signal 355 and operate as long-distance communications backups to each other. For example, CCI 220 can cooperate with CCI 120 by sampling and transmitting more frequently after receiving an indication from CCI 120 that a gas escape has occurred On Lease.

5 For further example, if either CCI 120 or CCI 220 cannot establish long-distance communications using its own multi-mode long-distance communications apparatus 420, then it may use signal 355 to communicate remotely using the apparatus 420 in the cooperating CCI as a relay. It is contemplated in installations where the SIT 210 downwind sensors are located sufficiently close to the critical lease, that the subsystems 211 may be configured to  
10 communicate directly with CCI 120 in order to further economize on equipment and bandwidth.

According to a preferred embodiment, the SMU of at least one SIT is enhanced with VID 310 a security camera, a triggering device ALARM 320, TX 330 a suitable RF transmitter (e.g. the VideoComm line of products), and VIDSERV 350 a suitable video processing and  
15 compression device (for example, but not in limitation, the Axis 2400/2401 JPEG video server that typically uses an 8 MB buffer and converts analog video into high quality digital images). Although according to a preferred embodiment VID 310 comprises a very compact CCD colour camera requiring less than 150 ma to operate, a wide range of video or still image devices are suited to this application. Similarly ALARM 320 is typically a motion sensor, a wide range of  
20 means of detecting an intruder (human, wildlife, vehicle, aircraft et cetera) approaching or passing through an access point in the critical lease perimeter will detect an event and generate a signal that may be used to trigger VIDSERV 350. In one embodiment VID 310 is supplied with power by the sensor unit 115 or other SMU supporting the SIT. VID 310 runs continuously collecting video images that are RF wirelessly transmitted by signal 330 on a suitable frequency  
25 that will not interfere with the RF module in either CCI 120 or CCI 220. VIDSERV 350 continuously receives signal 330 into a buffer that always has the most recent stream of images in storage having overwritten the previous stream. Until an event signal generated by ALARM 320 occurs the CCI operates in normal mode periodically transmitting environmental data, including averaged gas sensor readings. When an event signal is generated by ALARM 320,  
30 VIDSERV 350 accesses multi-mode long-distance communications apparatus 420 in a manner that depends on how it has been configured. In a preferred embodiment, when triggered by the event signal of ALARM 320, VIDSERV 350 activates Data Switch 340 (shown in Figure 4) interrupting access by CCI 120 via Serial Port 416 to take control of apparatus 420 and transmit the processed and compressed video image associated with the triggering event. In an alternate  
35 embodiment, VIDSERV 350 communicates through CCI 120 via an RS-232 serial or other

suitable port such as either Auxiliary Port 421 or Serial Port 422 and the firmware in 414a is programmed to treat signals at the appropriate port as a priority interrupt such that MCU 412 permits the processed and compressed video data stream to access apparatus 420 through Serial Port 416. VIDSERV 350 typically accepts raw video from VID 310 and signal 330, which video is processed to add any identification information (e.g. date, time, and location) required for the particular application and customer installation. In addition to adding required information, the video stream is compressed to any suitable format (e.g. JPEG) prior to being transferred from VIDSERV 350 to apparatus 420. VID 310 may be any suitable camera device but in a preferred embodiment comprises the Optex Wondertrack DC-300 Motion Detector and Camera combined having two relay outputs permitting transmission of signals to both VIDSERV 350 and a well site CCTV recording system. The DC-300 Alarm Output 1 is equipped with a photocell for optional Day/Night operation. The motion detection means typically comprises a passive infrared device, but a wide variety of (flash proof) switches, audio sensors, and similar devices may be used to generate a well site alarm.

According to an alternate embodiment, the transmission device creating signal 330 is not required since VID 310 may be mounted in proximity to VIDSERV 350 permitting a direct wireline connection for high rate data transfer.

ALARM 320 and/or VID 310 may be positioned on lease near access points or targets of concern arising with the presence of protesters, vandals, or terrorists. For example, in a terrorist attack on a gas well site, all the above system configurations work together with each function complementing the others for improved site records. Video devices detect the approach of and potentially provide identification evidence, system 100 provides confirmation of the nature and extent of the gas release associated with the attack, and system 200 provides confirmation of the direction and extent of any resulting release of  $H_2S$  in order to facilitate early warning to adjacent land owners.

Referring to Figure 10 there is illustrated in block diagram form the electronic components of a preferred embodiment of a CCI 120 or CCI 220 having removable sensor module 450 permitting the device to operate as a fully integrated system 100. As an example of

the "off the shelf" hardware that may be connected to systems 100, 200, or 300 of the present invention, the HART interface 525 is also illustrated.

Referring to Figure 4 there is illustrated an alternate embodiment of a CCI 120 or CCI 220 wherein local RF Module 410 is used to communicate wirelessly with a SIT (not shown) relaying input data from the sensor unit (not shown) in order to supply data for MCU 412 to process and distribute according to proprietary firmware stored in ROM 414a resulting in all conversions and averaging required to interpret the sensor data as well as adjusting the sensor data taking into account atmospheric conditions received through atmospheric conditions interface 415 from array 130. Upon initial processing of a single set of sensor data, EEPROM 414b is used to maintain a record thereof in the creation of a data log in which a plurality of sets of sensor data are averaged in accordance with said firmware in ROM 414a. Once the data over a programmable period of time is fully processed and adjusted, and the pre-programmed transmit time conditions are met, MCU 412 outputs via serial port 416 to apparatus 420 for transmission using a pre-existing CDPD or satellite network. Auxiliary I/O 421 and Serial Port 422 are both used to enable optional control and interaction alternatives that permit the CCI to be configured for different applications as well as to communicate with other systems and peripherals in the Job Shack. Charging circuit 423 and power Regulator 424 are used to maintain the batteries that supply the CCI.

Advantageously onboard voice phone 425 is provided in the housing of each of elements CCI 120 and CCI 220 in order to reduce the number of telephone devices that operators need to carry for initialization, maintenance, and emergency operation of the system of the present invention. When a system 100, 200, or 300 is installed to monitor well sites not within range of a cellular network the advantage, over conventional systems, of voice phone 425 becomes very significant permitting the operator to verify live readings and conduct tests in real time. According to a preferred embodiment phone 425 efficiently uses the same digital satellite or cellular modem and associated long-distance hardware and carrier account as is used for all environmental data transmissions.

According to a preferred embodiment apparatus 420 comprises a Global Star modem using dynamic IP addressing (to reach the satellite network) for strong data and system security



5 (vs. the less expensive but less secure CDPD cellular network option). Advantageously providing the communication element of system 100 or 200 using a common carrier, such as Global star, which is both voice and data capable reduces the complexity of each system as well as the combined system 300 - by operating through a single satellite network to transmit data to an InterNet accessible call center having a fixed IP address, where data is identified, recorded in a library manner, backed up, and available to be redistributed according to the well site operator's needs.

15 According to a preferred embodiment of the system of the present invention the CCI identifies the "modem of preference" in apparatus 420 using on-board RSSI (relative signal strength indicator) detection means to determine which modem best satisfies the firmware rules in ROM 414a. For example the rules may require for economy that the CCI always use CDPD (cellular) mode if the RSSI is at or above a pre-define transmission strength, but then automatically switch to Satellite mode if the RSSI drops too low to transmit reliably or quickly via CDPD. Further, driven by firmware the CCI may be instructed to continually (e.g. once per second) verify the RSSI level to select the appropriate modem based on specific events (e.g. alarm conditions or standard pre-scheduled delivery of data packets). The CCI housing also typically includes colour-coded LEDs for CDPD (e.g. green) and Satellite (e.g. red) modes in order to permit an operator or service person to determine which modem the CCI has so auto-selected.

25 According to an alternate embodiment Optional Switch 340 is installed in the communication path, between the serial output from the CCI 120 or CCI 220 motherboard and the apparatus 420, for the purpose of permitting VIDSERV 350 of the optional video security system to temporarily override or interrupt the transfer of environmental data in response to a security alarm event.

30 Referring to Figure 5 there is illustrated a block diagram of the SIT 210 element of Figures 2 and 3 that provides for the connection of a variety of different sensors (not shown) through port 505, which typically detect the presence of  $H_2S$  and  $SO_2$ . Since SIT 210 accepts unprocessed analog data from a variety of such different sensors, onboard MCU 520 (wherein

5 the processing firmware module is embedded with a RAM stack) is provided with Analog to Digital Converter 510 for the conversion of analog data from all sensor ports. Power Regulation Circuit 424, solar Charging Circuit 423 and auxiliary I/O module 421 are also provided for the supply of power to SIT 210 and to enable a variety of optional access and control features. RF module 530 wirelessly relays the converted sensor data to CCI 220 for further handling. Since  
10 SIT 210 is typically deployed spatially isolated from other SIT 210 units in a group, atmospheric conditions interface 415 is advantageously provided in each SIT 210 to permit the detection of a variety of potentially important weather related data over an area of several square kilometers. The weather data is converted to digital form prior to transmission by RF module 530, however it is not normally used by SIT 210 to adjust gas sensor data prior to receipt by CCI 220, wherein  
15 the gas sensor data is typically temperature compensated.

The SIT 210 configuration differs from the SIT 110 configuration in that SIT 110 normally operates as a slave to the external sensor unit from which it receives electrical power, whereas the SIT 210 has its own power supply, however the SIT 210 housing need NOT be  
20 intrinsically safe since it operates off lease at a downwind location where the risk of reaching the LEL of any flammable gas is negligible. SIT 210 is also configured to accept additional sensor input not required by the SIT 110 configuration that normally receives sensor input from a sophisticated external sensor unit 115, such as is illustrated in Figure 6 being a block diagram showing SIT 110 in use as a transmitting relay connected to sensor unit 115 being any suitable  
25 external gas analyzer. Referring to Figure 7 there is illustrated a block diagram of an alternate configuration instead showing SIT 210 in use as a detector and transmitting relay connected directly to sensors 116.

Advantageously the system and method of the present invention include and efficiently  
30 use an affordable novel combination of known technologies that is useful in a variety of well site monitoring applications that communicate with a remotely located control and monitoring centre using the InterNet.

Referring to Figure 8 there is illustrated an On Lease system 100 configuration installed  
35 at Location A, together with a Downwind system 200 configuration installed at Location C,

5 together with a combined system 300 configuration installed at Location B. The 3 installations communicate wirelessly using one or more routers 800 to reach the Internet. System 100 uses path 801 that may be for example CDPD cellular, while System 300 may be in a more remote location not having cellular infrastructure such that it uses path 803, which may be locked into for example the satellite mode using Global Star, at the same time as System 200 uses an auto-selection, auto-switching mode on path 802 to optimize communication economy as long as the CCI is not in alarm mode. As shown each of the systems is configured in Server mode, such that the CCI of each system "serve their data" directly to operators (e.g. users 821, 822 and 823) requiring a more comprehensive (non-summary) form of record. The "CCI Level" of access available to operators in "Server mode" provides detailed, very current information respecting the gas and other sensor readings at individual SIT 110 and 210 units. Access to the CCI 120 and CCI 220 in Server mode may also be used to "flash" the system (e.g. to reboot the MCU or clear the registers) or to cause the CCI to transmit the contents of its logging memory at virtually any time. It is contemplated that users 821, 822, and 823 may all work for a single larger entity running several locations with different risks, or they may work for different entities each entitled to access to the data for different reasons (e.g. corporate, government watchdogs), or they may work for different companies or venture partners having different access rights to different well sites.

Referring to Figure 9 there is illustrated, similar to Figure 8, a group of installations of different embodiments of the system of the present invention capable of cooperating in different ways and for different reasons, but here configured in "Client mode" requiring an external Server permitting end users (customers and operators) 921, 922, and 923 to access a summary of well site data being interpreted, consolidated, and served typically using an Internet web site to display data in a graphic and compact form that is easily understood. Although the user access may for some uses appear substantially similar to that gained under the connections established in Figure 8, the Server mode lends itself to the use of third party Call Centres that efficiently monitor around the clock more than one well-site for more than one Customer, as well as for easy sharing for regulatory, statistical or other value-added applications of the data available.

5           The terms and expressions employed in this specification are used as terms of description  
and not of limitation, and there is no intention in the use of such terms and expressions to  
exclude any equivalents of the features shown and described or portions thereof, and it is  
recognized that various modifications are possible within the scope of the invention claimed.  
Although the disclosure describes and illustrates various embodiments of the invention, it is to be  
10 understood that the invention is not limited to these particular embodiments. Many variations  
and modifications will now occur to those skilled in the art of remote well-site monitoring. For  
full definition of the scope of the invention, reference is to be made to the appended claims.